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Short-term effects of altering the dietary carbohydrate to fat ratio on circulating leptin and satiety in women

Michelle A. Gordon
University of Wollongong

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**SHORT-TERM EFFECTS OF ALTERING THE DIETARY
CARBOHYDRATE TO FAT RATIO ON CIRCULATING
LEPTIN AND SATIETY IN WOMEN**

A thesis submitted in fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

from

UNIVERSITY OF WOLLONGONG

by

MICHELLE A. GORDON, BSc (Honours), MSc (Nutrition & Dietetics)

DEPARTMENT OF BIOMEDICAL SCIENCE

2004

Declaration

I, Michelle A. Gordon, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Department of Biomedical Science, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. All work in this thesis has not been submitted for qualifications at any other academic institution.

Michelle A. Gordon

15th December 2004

Wollongong, Australia

Abstract

Background: Overweight and obesity have reached epidemic proportions and appetite control may be important for its clinical management. Leptin is a plasma protein secreted from adipose tissue that is involved in body weight regulation. The role of leptin in regulating human appetite is not well established. Human feeding studies report that an increased dietary carbohydrate to fat ratio is associated with increased circulating leptin concentrations compared to a decreased dietary carbohydrate to fat ratio. These investigations have generally used diets with extreme variations in macronutrient intake that do not represent normal patterns of consumption. Whether less extreme variations in macronutrient intake have similar effects on circulating leptin and whether there is a relationship with satiety under these conditions is not established. The overall aim of this research was to determine the potential clinical relevance of the effects of altering the dietary carbohydrate to fat ratio on circulating leptin concentrations.

Methods: Three short-term controlled human feeding studies were conducted involving 68 female subjects (age 37 ± 9 (SD) yrs, BMI 26.8 ± 4.1 kg/m²). Study 1 and Study 2 were single-blind parallel design trials where realistic high carbohydrate (carbohydrate:fat= 60:20) or high fat (carbohydrate:fat= 40:40) iso-caloric diets were provided. Study 3 was a double-blind cross-over trial where high carbohydrate (carbohydrate:fat= 60:20) and extreme high fat (carbohydrate:fat= 25:55) diets were provided. The primary outcomes were fasting leptin concentrations and subjective satiety measured on a multi-dimensional and single-dimension visual analogue scales. In Study 3 *ad libitum* intake was also assessed at a post-intervention buffet breakfast. Two-way repeated measures analysis of variance was used to analyse the effect of the intervention diets over time on the outcome measures.

Results: There was no between group difference in fasting leptin concentrations when realistic high carbohydrate and high fat controlled diets were consumed in Study 1 and Study 2 ($p>0.4$). This finding was similar when leptin concentrations were adjusted for body composition. Within subjects, changes in recent dietary carbohydrate and fat intake predicted a decrease in leptin concentrations during the intervention, but effects were small. A weak linear relationship between leptin concentrations and subjective satiety score was detected in Study 1 ($p=0.06$), but no relationship was detected in Study 2 and Study 3 ($p>0.7$). In Study 3 the more extreme high fat diet reduced leptin concentrations by 21% relative to the high carbohydrate diet (time*diet interaction, $p<0.01$). There was no influence of this difference in leptin concentration on *ad libitum* energy or macronutrient intake at the buffet breakfast (95% CI for difference in energy intake -411kJ to 190kJ).

Conclusions: Circulating leptin concentrations are influenced by dietary carbohydrate to fat ratio such that decreasing the carbohydrate content of the diet results in decreased circulating leptin concentrations. However, the potential clinical relevance of this finding to the management of overweight and obesity is likely to be limited as i) extreme dietary patterns are necessary to detect this effect, ii) leptin concentrations were not related to subjective satiety score and iii) differences in leptin concentrations did not influence *ad libitum* food intake. Further research is necessary to confirm these findings over longer time frames, with different subject groups, twenty four hour blood sampling and *ad libitum* intake over the entire day.

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List of Abbreviations

ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
BIA	Bioelectrical impedance analysis
BMI	Body mass index
CCK	Cholecystokinin
CHO	Carbohydrate
CNS	Central nervous system
DH	Diet history
DR	Dietary restraint
DXA	Dual energy x-ray absorptiometry
FR	Food record
%E	Percentage of energy
GI	Glycemic index
GLP-1	Glucagon like peptide-1
HC	High carbohydrate
HF	High fat
kJ	Kilojoule
MUFA	Monounsaturated fatty acid
NPY	Neuropeptide Y
PUFA	Polyunsaturated fatty acid
SD	Standard deviation
SEM	Standard error of the mean
SFA	Saturated fatty acid
TFEQ	Three factor eating questionnaire
VAS	Visual analogue scale
VMH	Ventromedial hypothalamus

Thesis publications and conference abstracts

Gordon MA, Tapsell LC, and Jenkins AB (2002). Normal variation in dietary intake influences circulating leptin in women. *Int J Obes* 2002; 26: S42.

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